Arthroscopic suture fixation of tibial spine fractures

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Indications

Type III or type IV fractures
Displaced type II that failed closed reduction
Block to extension
Simultaneous intra-articular injury requiring surgical intervention

Article Info

Keywords:
Tibial spine avulsion
Fracture
Sport medicine
Knee injury
Tibial eminence
Suture fixation
Knee trauma

Abstract

A tibial spine fracture refers to an intraarticular fracture of the osseous insertion of the anterior cruciate ligament at the proximal tibia, commonly seen in pediatric and adolescent patients. This fracture is classified based on the degree of displacement and the presence or absence of an intact posterior hinge point. For significantly displaced fractures, surgical reduction and fixation are often recommended. Both open and arthroscopic approaches have been described. This technical note describes our technique for arthroscopic-assisted reduction and fixation of tibial spine fractures using trans-osseous tunnels and suture fixation over a bone bridge. This technique restores native anatomy, provides fracture compression, and has favorable biomechanical properties, allowing for early range of motion.

Video Article

Video to this article can be found online at https://doi.org/10.1016/j.jisako.2024.02.012.

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Received 27 June 2023; Received in revised form 11 February 2024; Accepted 21 February 2024
Available online 20 March 2024

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Arthroscopic suture fixation of tibial spine fractures

1. Standard anterolateral, anteromedial, and portals are created.
2. The fracture edge is identified at the medial plateau and elevated using a Bankart elevator.
3. The interposed meniscus or inter-meniscal ligament is captured using a polydioxanone suture (PDS) suture and pulled anteriorly away from the fracture bed.
4. The fracture bed is cleaned with curettes and a 4.5 mm shaver.
5. A cannula is placed in the anterior medial portal to aid in suture management.
6. Two nonabsorbable, high-tensile #2 sutures are passed through the anterior cruciate ligament (ACL) footprint. One anterior and one posterior.
7. Anatomic reduction is achieved with the aid of an ACL tibial guide and knee extension.
8. 2.4 mm cannulated drills are used to create trans-osseous tunnels from the anterior medial tibia, exiting within the fracture fragment or just anterior, depending on the size.
9. A 1 cm bone bridge is left between the two tunnels.
10. One suture limb from each suture is passed through each tunnel, and the sutures are tied over the bone bridge with the knee in full extension.
11. Intraoperative ROM is tested to ensure fracture stability during early ROM.

TECHNIQUE STRUCTURE

Outline of the clinical problem

Tibial spine avulsions are intraarticular knee injuries consisting of an avulsion fracture of the tibial osseous insertion of the anterior cruciate ligament [1]. The injury occurs most commonly in patients with open physeal closure. The majority of patients with Type II, III, and IV fractures include skeletally immature patients with fracture types reported in children. Various studies have reported an associated injury pattern which considers rotation and comminution [5]. Meyers et al. have classified tibial spine avulsions based on the degree of displacement of the avulsed fragment, with Type I being nondisplaced, Type II being anteriorly displaced with an intact posterior hinge, and Type III being completely displaced [4]. Zaricznyj et al. have described a fourth type of injury pattern, which considers rotation and comminution [5].

Previously, tibial spine avulsion was thought to occur primarily as an isolated injury [6]. However, recent studies have highlighted high rates of associated pathology (such as meniscal tears or meniscal entrapment, other ligament injuries, and osteochondral injuries) with this pathology, even in young patients. Various studies have reported an associated injury rate with tibial spine avulsion ranging from 40.0% to 68.8% [6,7].

After a closed reduction, the effects of nonanatomical reduction increase the chance of nonunion or malunion and limit full extension [3]. The majority of Type II, III, and IV fractures are now often fixed as a result of recent improvements in surgical and arthroscopic procedures.

The best treatment option depends on multiple variables, including the surgeon’s preference, type of fracture, size of the fragment, and how to address concomitant injuries.

The arthroscopic procedure is less invasive. In addition, when compared to open reduction, arthroscopy offers more precise access to the fracture site, lower morbidity, earlier mobilization, and a shorter hospital stay [8].

The purpose of this technical note is to describe our preferred technique for arthroscopic-assisted fixation of tibial spine avulsions using suture fixation over a bone bridge.

Surgical indications and contraindications

Type I fractures can be treated nonoperatively with immobilization in extension. Arthroscopic-assisted or open reduction and fixation are indicated for displaced Type II fractures that fail a closed reduction. Acceptable limits of anterior displacement following closed reduction of Type II fractures continue to be studied, but less than 3–5 mm is currently considered adequate for nonoperative management [3,8]. Displaced Type III or Type IV fractures should be treated surgically, as well as in patients sustaining concomitant intraarticular injuries requiring surgical intervention [9]. The relative contraindications to fixation of tibial spine fractures include skeletally immature patients with fracture types that have been demonstrated to respond well to nonsurgical treatment [8].

Treatment options

Numerous open and arthroscopic-assisted surgical techniques have been described to treat displaced tibial spine avulsions. Fixation can be achieved with transosseous suture techniques, suture anchor-based fixation, or screw fixation.

While a screw fixation is simple and directly reduces and compresses the fragment, sutures can repair small or comminuted fragments.

Surgical technique

At the time of surgery, the patient is placed supine, and a thigh tourniquet is applied. The operative leg is prepared and draped in a sterile fashion.

An anterolateral arthroscopic portal is first established high and close to the patella tendon to allow for a top-down view of the tibial spine fracture. An anteromedial portal is established using a spinal needle entering just superior to the medial meniscus and directed appropriately for any concomitant meniscal work. The addition of a superior outflow portal can be used. However, the authors do not routinely use this. A standard diagnostic arthroscopy is performed.

With larger displaced fracture fragments, visualization in the notch is often challenging. Wide debridement of the fat pad is needed to be able to adequately visualize the tibial spine fracture bed. Care should be taken to preserve the inter-meniscal ligament (IML) during debridement. The fracture pattern is now delineated. The fracture line can often be seen extending into the anteromedial tibial plateau. The extension of the tibial plateau fracture is covered by the anterior horn of the lateral meniscus, which comes into near confluence with the tibial attachment point of the ACL. As such, the medial fracture line is best used to assess reduction.

Starting medially, a 15-degree “Bankart” elevator can be used to elevate the tibial spine fracture from the underlying plateau. One can then continue elevating anteriorly along the fracture line while protecting the IML. Once the fracture is elevated, the IML should be retracted anteriorly if it is overlying the anterior fracture line.

The fracture is now debrided of all soft tissue using a 4.5-mm shaver. To slightly recess the tibial spine fracture, a ring curette and an arthroscopic rasp can be used to remove a small amount of bone from the bed. Care should be taken not to remove more than a few millimeters, as it can be easy
to remove too much from the soft cancellous bed. A preliminary reduction can be trialed, and debridement/curretage can be tailored in order to remove blocks to reduce the fracture bed. Reduction of the tibial spine fragment is performed using an arthroscopic probe or an ACL tibial guide. A suture passer with a 45-degree curve is used from the AM portal to pass through the posterior one-third of the ACL fibers. The passing suture is retrieved through the AM portal, and a number 2 high-tensile, nonabsorbable suture is passed through the ACL utilizing the passing suture. A second pass is made through the anterior one-third of the ACL fibers, again hugging the ACL insertion. It is helpful to use two different-color sutures for suture management.

An ACL tibial guide is now used to hold the reduction of a tibial spine fracture. It should be positioned for the first drill tunnel at the anteromedial portion of the fracture, a few millimeters posterior to the anterior fracture line. A 2.4-mm cannulated drill is used. An anteromedial 2-cm incision is created halfway between the tibial tubercle and the posterosmedial aspect of the tibia. A second drill bit can then be placed at the anterolateral aspect of the tibial spine. The two 2.4-mm drill tunnels are created in a vertical fashion (tibial guide set at 60°). Care should be taken not to drill multiple passes to minimize damage to the physis. It is critical to ensure that the start point of the second drill bit on the tibia is at least 1 cm from the previous tunnel to ensure an adequate bone bridge.

The central wire is removed from the cannulated drill, and a nitinol passing suture is utilized to bring the medially-based sutures out of the medial tunnel and the lateral-based sutures out of the lateral tunnel.

Once the sutures are passed, the knee is extended while applying tension to the sutures to achieve adequate compression of the fracture. The sutures are then tied. The stability of the fracture is assessed through a range of motion. Portal closure is performed, as is the placement of dressings, including immobilization of the knee in a hinge knee brace.

Postoperative care: During the first 2 weeks, the knee was placed in full extension with the brace and nonweight bearing. Then, the ambulation program begins with weight-bearing as tolerated and progressive knee flexion up to 90°. Low-impact activities are allowed at 4 months postoperatively, and full sporting activities are resumed at 6 months.

Outcomes of the technique

Surgical reduction fixation can be performed through arthroscopic or open techniques. Studies have reported comparable or better results with arthroscopic fixation [9]. Multiple fixation methods have been published, and biomechanical data suggests that suture-based techniques provide greater fixation strength than screw constructs under cyclic loading of the knee [10].

Similarly, Callanan et al. found that suture fixation is preferable to screw fixation due to a lower risk of reoperation to remove the hardware and fewer image artifacts on postoperative magnetic resonance imaging. Nevertheless, the screw fixation technique required less time in the operating room, better International Knee Documentation Committee Subjective Knee Form (IKDC) scores, and a lower incidence of glide pivot shift after surgery [1]. It should be noted that some of these studies were small, retrospective, and included skeletally mature patients.

There are several protocols for postoperative rehabilitation. In the past, even patients who underwent surgical intervention were required to remain immobilized for a long period afterward. Starting range of motion within 4 weeks of immobilization resulted in a decreased rate of knee stiffness [9]. Current surgical techniques allow early mobilization and protected weight bearing; our protocol suggests that this can begin within 2–6 weeks postoperatively.

A gradual return to athletic activity as tolerated and sports clearance typically takes 6 months, though this might vary significantly depending on how quickly the rehabilitation course progresses [9]. We apply the same return-to-play standards to patients who are having ACL reconstruction prior to returning to a full-sport activity.

Complications

Complications of surgical management include arthrofibrosis, nonunion, residual knee laxity, anterior knee pain, muscle weakness, and growth arrest in the skeletally immature patient [9]. Arthrofibrosis is the most frequently reported consequence following this kind of injury, with reporting rates up to 11%. The common risk factor for such a complication is extended knee immobilization for longer than 4 weeks after injury. A nonhealing fracture following a tibial spine injury is uncommon and may result secondary to improper reduction or fixation. Anterior knee laxity has been observed following surgical and nonsurgical treatment of tibial spine fractures, which are usually asymptomatic [9,11].

CONCLUSIONS AND FUTURE PERSPECTIVES

Tibial spine surgical fixation aims to reduce the fracture in the proper position, restoring the ACL length and tension to allow for appropriate function. Suture fixation over a bone bridge is used to accomplish this and allow for early knee range of motion to prevent arthrofibrosis.

Future research is necessary to assess whether suture fixation results in better outcomes than alternative fixation methods in terms of return to activity, range of motion, and need for revision surgery.

Funding

None.

Financial remuneration/biases for any author

None.

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